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Melt–Electrospun Polyprophylene Fabrics Functionalized with TiO2 Nanoparticles for Effective Photocatalytic Decolorization

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Abstract : Currently, textile industry has played an important role in world's economy, especially in developing countries. Dyes and pigments used in textile industry are significant pollutants. Most of theirs are azo dyes that have chromophore (-N=N-) in their structure. There are many methods for removal of the dyes from wastewater such as chemical coagulation, flocculation, precipitation and ozonation. But these methods have numerous disadvantages and alternative methods are needed for wastewater decolorization. Titanium-mediated photodegradation has been used generally due to non-toxic, insoluble, inexpensive, and highly reactive properties of titanium dioxide semiconductor (TiO2). Melt electrospinning is an attractive manufacturing process for thin fiber production through electrospinning from PP (Polyprophylene). PP fibers have been widely used in the filtration due to theirs unique properties such as hydrophobicity, good mechanical strength, chemical resistance and low-cost production. In this study, we aimed to investigate the effect of titanium nanoparticle localization and amine modification on the dye degradation. The applicability of the prepared chemical activated composite and pristine fabrics for a novel treatment of dyeing wastewater were evaluated.In this study, a photocatalyzer material was prepared from nTi (titanium dioxide nanoparticles) and PP by a melt-electrospinning technique. The electrospinning parameters of pristine PP and PP/nTi nanocomposite fabrics were optimized. Before functionalization with nTi, the surface of fabrics was activated by a technique using glutaraldehyde (GA) and polyethyleneimine to promote the dye degredation. Pristine PP and PP/nTi nanocomposite melt-electrospun fabrics were characterized using scanning electron microscopy (SEM) and X-Ray Photon Spectroscopy (XPS). Methyl orange (MO) was used as a model compound for the decolorization experiments. Photocatalytic performance of nTi-loaded pristine and nanocomposite melt-electrospun filters was investigated by varying initial dye concentration 10, 20, 40 mg/L). nTi-PP composite fabrics were successfully processed into a uniform, fibrous network of beadless fibers with diameters of 800±0.4 nm. The process parameters were determined as a voltage of 30 kV, a working distance of 5 cm, a temperature of the thermocouple and hotcoil of 260–300 ºC and a flow rate of 0.07 mL/h. SEM results indicated that TiO2 nanoparticles were deposited uniformly on the nanofibers and XPS results confirmed the presence of titanium nanoparticles and generation of amine groups after modification. According to photocatalytic decolarization test results, nTi-loaded GA-treated pristine or nTi-PP nanocomposite fabric filtern have superior properties, especially over 90% decolorization efficiency at GA-treated pristine and nTi-PP composite PP fabrics. In this work, as a photocatalyzer for wastewater treatment, surface functionalized with nTi melt-electrospun fabrics from PP were prepared. Results showed melt-electrospun nTi-loaded GA-tretaed composite or pristine PP fabrics have a great potential for use as a photocatalytic filter to decolorization of wastewater and thus, requires further investigation.

Keywords : titanium oxide nanoparticles, polyprophylene, melt-electrospinning
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